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Comparative LCA of repairing flooded houses versus construction of a dam

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Coastal ecosystems and human infrastructures are under the constant threat of floods. Accounting for half of the natural disasters [1], flooding is amongst the most impactful calamity. Moreover, Sea Level Rise (SLR) is expected to locally increase the risk and resulting damage of these events. SLR will increase both flood frequency and depths in most of the world, even though the effect is not geographically uniform. In the case of northern Europe (Baltic and North Seas), a relative expected SLR up to 80cm is expected [2]. Combined with a growing urban density of inhabitants and infrastructures, this makes flood risk a rapidly growing concern for society that demands focus.

A range of solutions for protecting and mitigating flood risk in cities exists and numerous others are being developed. These solutions are mostly being assessed using risk assessment frameworks where risk is defined as a combination of potential economic damage and probability of occurrence. When environmental impact is included, which it seldom is, the is either done qualitatively and or with rather limited scopes. Instead, here, the analysis is made from an environmental viewpoint, using the holistic Life Cycle Assessment (LCA) framework to compare the impact of constructing a dam (cf. Figure 1) and the post-disaster reparation of houses were the dam not built.

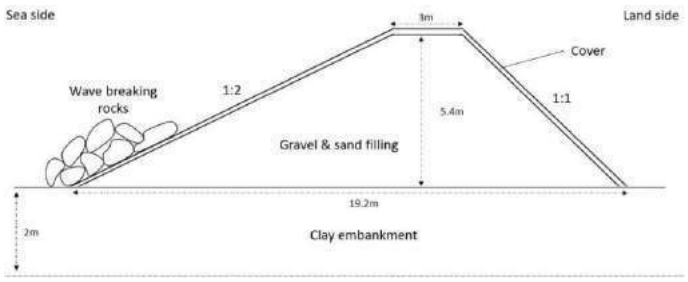

Figure 1 - Cross section of the modelled dam protecting the Avedøre Holme area in Copenhagen.

The method chosen intends to reconcile the fields of environment assessment and risk assessment. To do so, LCA is paired with a probabilistic approach, namely a Monte Carlo analysis. The SLR related water levels yielded by the simulation are fed into an environmental impact calculator. Then, the resulting probability densities, for each category, are compared to the impact of building the dam. Finally, the probability of having a positive environmental bill is deduced. This methodology is applied to two case studies in Copenhagen and northern Zealand with a time scope of a century.

Preliminary results indicate that the solution of the dam, in either case, is largely preferable. Indeed, with SLR, the number of damaging storms goes skyrocketing to the point where a dam seems necessary unless all the houses concerned are planned to be relocated in the next twenty years or so.

[1] D. Guha-Sapir, “2016 preliminary data1: Human impact of natural disasters,” 2016.

[2] A. Grinsted, S. Jevrejeva, R. E. M. Riva, and D. Dahl-Jensen, “Sea level rise projections for Northern Europe under RCP8.5,” *Clim. Res.*, vol. 64, no. 1, pp. 15–23, 2015.